

Characterizing the Kinetics and Mechanisms of Ion Sorption to Soil Components Employing Infrared and Optical Spectroscopy

Dr. Donald L. Sparks

Department of Plant and Soil Sciences

University of Delaware, Newark, Delaware 19717-1303

Project Goal:

The overall objective of this research is to use synchrotron-based FTIR spectro-microscopy to aid in the identification of metal and oxyanion sorption products on soil materials. Specifically, our efforts will be focused towards characterization of inorganic contaminant speciation to organic and mineral components within various soil types. This research will benefit from the higher flux and, consequently, greater spatial resolution available with synchrotron radiation.

Our specific goals within the last proposal periods were: 1) to identify sample cells compatible with the endstation spectrometer(s) at Beamline 1.4.3 that were suitable for the analysis of soil materials, and 2) to help establish a wet chemical laboratory adjacent to the beamline. In addition, we evaluated potential experimental and instrumental limitations which could interfere with the proper identification of analyte speciation.

Project Accomplishments:

We have performed preliminary analyses using the NicPlan Microscope available on the spectro-microscopy endstation of Beamline 1.4. Our results suggest that this technique will be successful for the characterization of analyte-soil associations provided that certain experimental and instrumental requirements are satisfied. With respect to instrumentation, reliable control of the atmosphere surrounding the sample is essential due to potential interference from common absorbing species in air, e.g. H₂O and CO₂. In addition, important requirements must be met with respect to sample characteristics. Foremost, for optimal results the particle size distribution of the soil material cannot be significantly smaller than the spatial resolution of the spectrometer. This may limit examination of the clay size fraction (<2 μm), which is generally considered to be the most reactive fraction within a soil. Research should focus on identifying analyte speciation and distribution in heterogeneous materials. Finally, characterization of soil materials reacted with metals or oxyanions suggest that studies examining the latter compounds will prove more fruitful. Our initial hope that the improved spatial resolution available with the synchrotron source would facilitate identification of metal hydroxide precipitation products was unfulfilled. These studies will likely only prove successful when the spectral signature of the reaction product and soil material are significantly different. In most cases, characterization of sorption products for oxyanions such as arsenate, borate and phosphate will not suffer from this limitation.

This research was supported by the USDA-NRICGP, DuPont, and the State of Delaware.

Principal investigator: Donald L Sparks, Department of Plant and Soil Sciences, University of Delaware. Email: dlsparks@udel.edu. Telephone: 302-831-2532.